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On the relationships among work characteristics and learning-related behavior: Does age matter?

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Summary

This 3-wave longitudinal study examined (a) the causal direction of the relationships among psychosocial work characteristics (e.g., job demands, job control, and supervisor support) and indicators of learning-related behavior (e.g., motivation to learn and active problem solving), and (b) whether these relationships differed across age, by comparing the results for young (≤ 30), middle-aged (31–44) and older (≥ 45) workers. The results for the total sample revealed significant reciprocal causal relationships among job demands, job control, and learning-related behavior. Furthermore, significant age differences were found in the level of the work characteristics and learning-related behavior, as well as in the cross-lagged relationships among the variables. Compared to earlier—predominantly cross-sectional—results, the present study underlines the importance of taking a dynamic as well as a life-span view on the relationships between work and learning-related behavior. Copyright © 2009 John Wiley & Sons, Ltd.

Introduction

Due to the challenges posed by the dynamic labor market, global competition and technological innovation, lifelong learning ranks high among the topics on the management as well as research agenda (Nijhof, 2005; Ouwenel, Taris, Van Zolingen, & Schreurs, 2009). Past research has revealed that contemporary careers can be viewed as a series of learning cycles across a person's life (Hall, Zhu, & Yan, 2002), and that learning must be examined in relation to the context in which it occurs,

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including the characteristics of one's job (Poel, Van Dam, & Van den Berg, 2004; Taris, Kompier, De Lange, Schaufeli, & Schreurs, 2003).

Although the work environment (especially job characteristics such as job autonomy) is often regarded as a major determinant of learning, studies examining the links between work and learning in a longitudinal perspective are still scarce (e.g., Holman & Wall, 2002; Taris & Kompier, 2004). Moreover, current research on the learning-related effects of the job environment neglects age differences and changes in informal learning at work across time (Poel et al., 2004). This is remarkable, as forecasts suggest that the number of older workers in the Western world will substantially increase, while the number of young workers will decrease (European Commission, 2005; Kanfer & Ackerman, 2004). Further, as the safety net of funded (early) retirement is currently being withdrawn worldwide, it appears likely that many workers will not retire before the age of 65. Consequently, in the not-so-distant future companies will increasingly rely on the work of older employees. Although this group of workers has attracted considerable research interest, as yet their career development, well-being and learning-related behavior have not been studied extensively (De Lange, Taris, Jansen, Smulders, Houtman, & Kompier, 2006; Warr, 2007, 2008). Drawing on data from 1237 Dutch workers, the present study was designed to fill this gap by examining the longitudinal relationships among work characteristics and learning-related behavior in the context of age.

Learning and the psychosocial work environment

It is often proposed that the *psychosocial* work environment, referring to psychological and social job conditions, affects worker well-being. One influential example of such a model is Karasek and Theorell's (1990) Demand–Control–Support (DCS) model. According to the *activation hypothesis* of this model, people working in jobs characterized by high job demands, high control, and high social supervisor support (i.e., *active* jobs), will develop high intrinsic motivation for learning and personal growth. In active jobs workers are not only continuously exposed to challenging job demands but also have the autonomy and social support to explore different ways of dealing with the job demands. The exposure to this challenging, but resourceful work environment will promote learning (Bandura, 1997). Karasek and Theorell (1990) define learning-related behavior as "... an environmentally facilitated, active approach toward learning new behavior patterns" (p. 170). Taris and Kompier (2004) argue that workers under time pressure and quantitative overload have little opportunity for setting new goals and developing new action plans, and tend to revert to prior automatized skills, which results in lower levels of learning-related behavior. However, in active jobs supervisors can provide a learning climate that encourages workers to learn new behavior, to show more personal initiative, and to develop new action plans (Frese, Garst, & Fay, 2007; Warr, Allan, & Birdi, 1999).

Conversely, people working in jobs with low job demands, low control, and low social support (*passive* jobs) will display low levels of activation and learning-related behavior, as the individual experiences few learning opportunities. Further, people working in *low-strain* jobs (with low job demands, high control, and social support) and *high-strain* jobs (characterized by high job demands, low job control, and social support) will experience moderate levels of intrinsic motivation, as the individual possesses insufficient resources to respond optimally to situational demands (Holman & Wall, 2002; Karasek & Theorell, 1990; Taris et al., 2003).

In line with De Lange, Taris, Kompier, Houtman, and Bongers (2003), in this study we consider the activation hypothesis supported when: (i) High job demands are related to more learning-related behavior (Hypothesis 1a), (ii) high job control is related to more learning-related behavior (Hypothesis 1b), and (iii) high supervisor support is related to more learning-related behavior across time (Hypothesis 1c) (cf. the paths A in Figure 1). Furthermore, as we want to examine the effects of

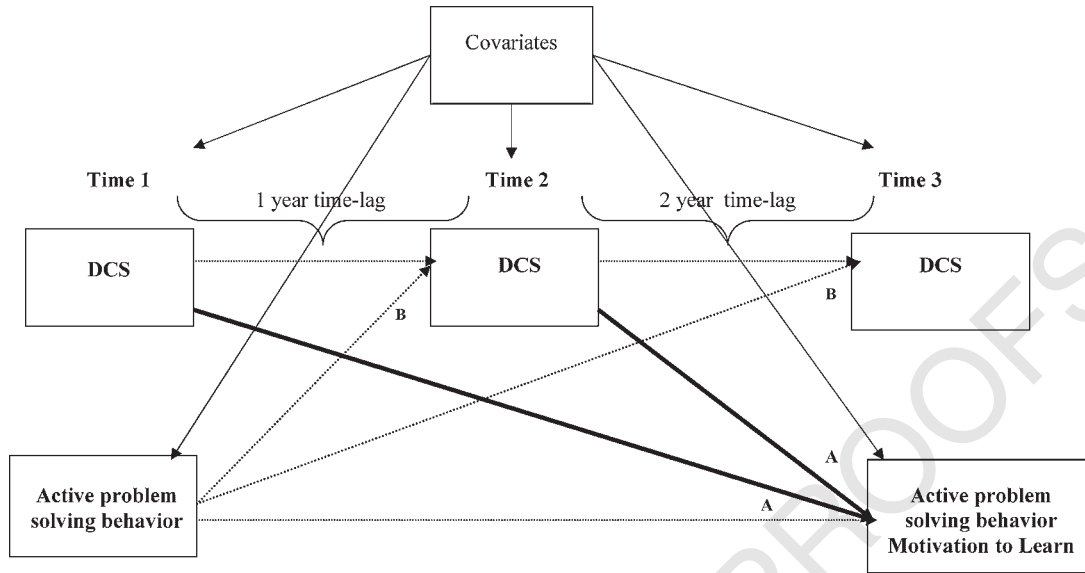


Figure 1. Research model (M_0) for the relation between DCS dimensions and learning-related behavior
 Note: DCS refers to demands, control and supervisor support; A refers to normal cross-lagged paths from DCS dimensions to learning-related behavior, and B refers to the control for reversed cross-lagged paths from active problem solving to the DCS dimensions

continuous exposure to these psychosocial work characteristics, we will control for the stability of these measures in our analyses.

The active shaper hypothesis

Besides the aforementioned “normal” causal effects of psychosocial work characteristics on learning-related behavior across time, we want to provide the first longitudinal test for possible “reversed” effects of active problem solving (cf. Figure 1, paths B; De Lange, Taris, Kompier, Houtman, & Bongers, 2005). In line with life-span developmental theory (Taris, Bok, & Caljé, 1998), we argue that employees are active shapers of their work environment, not just passive receivers of environmental influences. According to Wrzesniewski and Dutton (2001), employees react to their perceptions of the social or work context, and have autonomy to define and enact on the job. Frese et al. (2007) refer in this context to the concept of *reciprocal determinism* (cf. Bandura, 1997), stating that people can be the producer as well as the product of their social systems. Consistent with this reasoning, we expect that workers who engage in active problem solving will be more effective in creating or using job resources like job control and/or social support than workers who display less problem solving behavior (de Lange, De Witte, & Notelaers, 2008). Through widening their thought and action repertoire, active problem solvers will be better at crafting their jobs by selecting different job resources or promotion opportunities; resulting in improved emotion regulation (Fredrickson, 2001; Gross, 1998; Hobfoll, 2001; Salanova, Bakker, & Llorens, 2006). Thus, learning may also lead to changes in the job environment of workers.

The direction of a possible reversed effect of active problem solving on job demands is less clear. For example, active problem solvers may be more effective in reducing job demands, suggesting that active problem solvers will experience lower job demands in time. However, they may also attempt to make

their job more interesting and challenging, which could lead to *higher*, rather than lower demands (De Lange et al., 2008). Thus, it is difficult to hypothesize about the direction of the effects of active problem solving on job demands.

Previous longitudinal research has provided some evidence for reciprocal relationships among psychosocial work characteristics on the one hand, and mental health indicators (De Lange, Taris, Kompier, Houtman, & Bongers, 2004; Taris, Kompier, Geurts, Houtman, & Van den Heuvel, in press; Ter Doest & De Jonge, 2006) and personal initiative on the other (Frese et al., 2007). However, this dynamic longitudinal perspective has not been taken in the context of learning-related behavior. Consistent with previous research on the relationships between work characteristics and mental health, we will therefore examine whether we can find evidence for reciprocal relations between psychosocial work characteristics and learning-related behavior (Hypothesis 2; Figure 1, paths B).

Age differences in the evaluation of work

Many researchers examining the DCS model routinely control for age in their studies. De Lange, Taris, Kompier, Houtman, and Bongers (2003) showed that of the 45 longitudinal studies included in their review on the Demand–Control–(Support) model, 91 per cent controlled for demographic variables, among which age. However, none of these studies provided arguments *why* or *how* age would affect the relationship between psychosocial work characteristics and well-being. Age has often been studied as a covariate or confounder in occupational health research, but relatively few studies have taken a life span perspective on vocational interests, values or the importance of various job dimensions such as task complexity, autonomy, and variety (Griffiths, 1997; Kanfer & Ackerman, 2004; Warr, 2008). In this study we therefore examine the prevalence of age differences in the level of psychosocial work characteristics and learning-related behavior. Note that age can be studied as both *intra-individual* (within-person) change and *inter-individual* (between-person) change (Baltes & Nesselroade, 1979, p. 3). The examination of potential intra-individual change as a function of age is necessary to enhance our understanding of the across-time relationships among work and learning-related behavior. We start with discussing potential age group differences, highlighting relevant life span developmental theories to hypothesize further on how age may play a role in work and learning.

Age group

The distinction between younger and older employees is often based on the respondent's chronological or calendar age. The meaning of the term "older worker" may vary to include workers from age 40 to 75, depending on the purpose of the organization as well as the needs of the worker (Collins, 2003). Although the cut-off point between young and older workers is not fixed, throughout this paper we use the often employed threshold of 45 years to refer to older employees versus younger or middle-aged workers (cf. Stroh & Greller, 1995; Warr, 2000). Specifically, we examine whether older workers (≥ 45 years) differ significantly from young (≤ 30 years) and middle-aged workers (31–44 years) regarding the level of reported psychosocial work characteristics as well as learning-related outcomes.

Life span developmental theory and learning: Hold on to what you got?

According to Baltes' (1987) life span theory, the motivational process of striving toward maximization of gains and minimization of losses becomes more salient as people age, because of the loss of biological, mental as well as social reserves across the life span (Bajor & Baltes, 2003; Higgins, 1997;

Hobfoll & Shirom, 2001). According to the Selection Optimization with Compensation (SOC) model of Baltes, Staudinger, and Lindenberger (1999), the allocation of resources for so-called “growth or promotion” goals decreases with age, whereas maintenance and regulation of “loss or prevention” goals increases with age. Similarly, Carstensen’s socio-emotional selectivity life span theory (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000) proposes that individuals will select goals in accordance with their perceptions of the future as being limited or open-ended (Lang & Carstensen, 2002). Younger generations would perceive time as being open-ended (holding a “time since birth” perspective) and will be especially motivated by growth or *knowledge-related* goals (acquiring new information or social interactions) that can be useful in the more distant future. In contrast, older generations would perceive time as constraint (holding a “time till death” perspective), and will be more motivated by achieving short-term emotion-related goals, such as deepening one’s existing relations. As for older workers retirement will arrive sooner than for young or middle-aged workers, work-related future perspectives also decrease faster for older workers (Carstensen, Isaacowitz, & Charles, 1999). As a consequence, older workers may look for more emotion instead of learning-related aspects in their work environment. In sum, these approaches suggest that older workers experience a relatively lower need to learn new skills than their younger colleagues.

In line with these life span theories, earlier research has shown that as people age their openness to new experiences and change decreases (Terracciano, McCrae, Brant, & Costa, 2005). Kanfer and Ackerman (2004) suggest that aging workers face a loss of fluid intellectual abilities, which may negatively affect their learning outcomes. For example, a decline in memory may lead to cognitive slowing, reductions in processing resources, and deficits in reflective processes (Hess, 2005). However, research has also shown that older workers have better emotion regulation skills compared to their younger colleagues, and tend to use more passive, intrapersonal emotion-focused forms of coping skills instead of active problem-focused behavior (Charles, Reynolds, & Gatz, 2001; Folkman, Lazarus, Pimley, & Novacek, 1987). Applying these findings to learning-related behavior, the relatively high level of expertise and knowledge of older workers may result in a lower need to learn new behavior compared to younger workers. We therefore expect older workers to report lower levels of learning motivation and active problem solving than others (Hypothesis 3).

Life span developmental theory and psychosocial work characteristics: Old and wise versus old and out?

Warr (2007) reviewed the research on age-related preferences in job features, finding that age was positively associated with increased preferences for physical security, salary, and opportunities for skill utilization, and negatively associated with the importance of high job demands, job variety, and provision of external goal assignments. He argues that older workers are likely to have different job concerns than younger ones, due to life span changes such as changed family position, experience, and perceptions of themselves at different stages in the life course. Furthermore, career developmental theories focus on the idea that one’s self-concept becomes more clearly defined with age and that career choice is a process of matching one’s self-concept with images of the occupational world (Watkins & Subich, 1995), suggesting that older workers will have obtained careers that better *fit* their self-concept. Similarly, Wright and Hamilton’s (1978) job change hypothesis assumes that due to experience, seniority, and skills, the group of active older workers will have obtained a relatively better person–environment fit, and higher level occupations with more job control than their younger colleagues (Edwards, Cable, Williamson, Lambert, & Shipp, 2006).

Relevant for knowledge acquisition is also the feedback and social support of supervisors (Karasek, 1979). Because of their “time till death” perspective, older workers tend to be more selective in investing time and effort in emotionally close interaction partners, and to reduce the effort invested in

acquiring new social contacts (Carstensen, 1998). Moreover, supervisors may hold negative stereotypes about older workers. As a result, they may provide older workers with less stimulating feedback or support than others (Van der Heijden, 2006; Van der Heijden, De Lange, Demerouti, & Van de Heijde, 2009). We therefore expect older workers to report a significantly higher level of job control, and a lower level of supervisor support than other workers (Hypothesis 4). As there is no relevant age-related research on job demands, we will not specify hypotheses for job demands.

Intra-individual age effects?

Besides age differences with respect to the scores on the DCS dimensions and learning-related behavior, it is also important to address potential intra-individual, cross-lagged changes in the relationships between psychosocial work characteristics and learning-related behavior. Earlier research (Bal, De Lange, Jansen, & Van der Velde, 2008; Rousseau, 2001) revealed that older workers may experience dampening of emotional responsiveness and possess stable mental models about their employment situations, and they may therefore react less strongly to the same job demands than younger workers. This could lead to weaker cross-lagged effects for older as compared to young and middle-aged workers. Moreover, as older workers will on average have held their jobs for a relatively long time, they may experience fewer learning stimuli from their psychosocial work environment than workers who have just entered the labor market (Park, 1994). Considering the scarce research on these issues, we do not specify specific hypotheses here. Instead, we exploratory test whether the relationships between psychosocial work characteristics and learning-related behavior differ as a function of age.

Organizational Context

Sample

This study was initiated in 1993 by the Dutch TNO Work & Employment in order to identify work-related risk factors for musculoskeletal complaints (Ariëns, Bongers, Miedema, Van der Wal, Bouter, & Van Mechelen, 2001; Hoogendoorn et al., 2000). In cooperation with Dutch occupational health services, a representative group of 2064 workers from 34 companies of various industrial and service sectors, located throughout the Netherlands, were selected to participate in the study on musculoskeletal disorders, absenteeism, stress and health (SMASH). Both blue-collar (65.2 per cent) and white-collar (26.3 per cent) jobs were included. In order to be included, companies should not be involved in major reorganizations during the 3 years of examination and the pre-study annual turnover rate of their workforce should be lower than 15 per cent. Further, in order to realize enough exposure to the current psychosocial work characteristics, we selected only respondents who had been working for at least 1 year and held a permanent contract for at least 20 hours per week.

Labor market perspective

During the time period in which this study was carried out, the situation on the Dutch labor market was relatively stable. Many social funds were available such as good pension programs. Consequently, there were few financial incentives for older workers to remain active on the labor market, resulting in high percentages of workers who voluntarily retired before the age of 60. In comparison to Dutch trend data of the early 1990s as well as more recent trend data (Houtman et al.,

2004), our sample reported a comparable job autonomy, and relatively higher work pressure scores. For example, of the Dutch work population, 65 per cent in 1994 to 73 per cent in 2002 reported to have decision latitude. In our panel 59 per cent of the participants reported to have decision latitude. For work pressure, percentages of 38 per cent in 1994 to 41 per cent in 2002 were found for the Dutch work population, as compared to 59.8 per cent for our sample.

Method

Subjects

Of the invited workers, 1742 (84 per cent) participated at baseline in this study. At each wave (i.e., Time 1, 1994; Time 2, 1995; and Time 3, 1997) the respondents completed a self-report questionnaire, tapping concepts such as general working conditions, changes in the workplace, psychosocial work characteristics, psychosocial and physical health, and background factors. The learning-related outcomes were measured on Time 1 (active problem solving) and Time 3 (active problem solving and motivation to learn). The response rates were relatively high and varied from 84 per cent ($N = 1742$) at baseline to 85 per cent ($N = 1473$) at the third follow-up measurement, as compared to the previous wave. Non-response analysis revealed that drop-outs tended to be younger, and reported a lower level of education, more strain, and less control across time, a quite common phenomenon in longitudinal research (Taris, 2000). Furthermore, we examined the means for demands, control, and supervisor support for the blue collar versus white collar jobs, and found only significant differences in job control on Time 1 ($F(1, 1730) = 130.6$), Time 2 ($F(1, 1405) = 76.7$), and Time 3 ($F(1, 1390) = 61.2$). Further, blue collar workers reported lower job control scores than white collar workers. After listwise deletion of missing values the sample included 1237 respondents.

Measures

Job demands

Job demands were measured using a five-item Dutch version of Karasek's (1985) Job Content Questionnaire (e.g., "My job requires working very fast," "my job requires working very hard," 1 = "strongly disagree," 4 = "strongly agree"). The reliability (Cronbach's α) of this scale varied from .65 to .72 across waves (median $\alpha = .71$).

Job control

Consistent with Karasek (1979), job control was measured as the mean of two scales. *Skill discretion* was measured using a five-item scale (e.g., "my job requires creativity" and "my job requires learning new things"), and *decision authority* was measured using a three-item scale (e.g., "My job allows me to take many decisions on my own," "I have many opportunities to participate in decision making about my job," 1 = "strongly disagree," 4 = "strongly agree"). The reliabilities of the job control scale ranged from .81 to .83 (median $\alpha = .83$).

Supervisor support

Supervisor support was measured using a four-item Dutch version of Karasek's (1985) Job Content Questionnaire (e.g., "My supervisor pays attention to what I say," 1 = "strongly disagree,"

4 = “strongly agree”). The reliability (Cronbach’s α) of this scale varied from .82 to .88 across occasions (median α = .86).

Learning-related behavior was measured by the scales Motivation to learn and Active problem solving. *Motivation to learn* refers to the degree to which workers report that their job motivates them to learn new behavior patterns and skills on their job, or that they have to solve problems at their job (Taris & Kompier, 2004). This approach is consistent with the definition of Karasek and Theorell (1990), who defined active learning in terms of an active approach toward learning new behavior and solving new problems. The concept was measured with a validated seven-item Dutch scale developed by Van Mierlo, Rutte, Kompier, and Seinen (2001). Typical items are: In my work: “I feel challenged by new problems,” “I look for solutions for problems of colleagues,” “I continue to work on a problem until it is resolved” 1 = “never,” 4 = “often”). The reliability (Cronbach’s α) of this scale, only measured on Time 3, was .83. *Active problem solving* was measured by four items of the Dutch active coping scale (Schreurs, Van der Willige, Tellegen, & Brosschot, 1988), including items such as “I perceive problems as challenges;” “I compare different solutions in solving a problem;” “I work goal-oriented in solving problems,” 1 = “never,” 4 = “always”). The reliability (Cronbach’s α) of this scale varied from .75 to .77 on Time 1 and Time 3. As expected, exploratory factor analysis revealed that the psychosocial work characteristics and learning-related behavior items measured different underlying factors.

Covariates

Gender, educational level, and job tenure were used as covariates in the analysis, because these variables may be significantly related to the outcome variables in this study. Failing to control for these variables may bias the effects of other variables.

Statistical analysis

Structural equation modeling (SEM; Jöreskog & Sörbom, 1993) was used to test and compare various competing models for the relationships among demands, control and supervisor support, and learning related behavior across time. SEM provides global measures of fit. In the present research we performed a comparative analysis in which the fit of several competing models was assessed to determine which model fitted the data best. Considering the problems caused by estimating all observed items and latent variables (low statistical power and model under-identification, Bentler & Chou, 1987), we assumed the scale and latent variables to be identical. However, following the two-step approach proposed by James, Mulaik, and Brett (1982) we first tested the measurement models for each of the variables before fitting the structural models (these results can be obtained from the first author). These analyses showed that the factor structures of the research variables were consistent across time. Finally, we report the standardized results, based upon an analysis of the covariances among the variables.

To examine the causal relationships between the DCS dimensions and learning-related behavior (Hypotheses 1 and 2) we tested a baseline model versus several competing nested models. We tested the following models:

- (M0) Baseline model: Includes temporal stabilities and synchronous effects (e.g., DCS measures were allowed to correlate with one another within the same time wave) of variables over time and controls for the influence of the covariates age, gender, level of education, and job tenure. This model is used as the reference model.
- (M1) Normal causation model: M₀ extended with cross-lagged structural paths from the Time 1, Time 2, and Time 3 DCS dimensions to Time 3 learning-related behavior (active problem solving and motivation to learn; cf. Figure 1).

- (M2) Reversed causation model: M_0 extended with cross-lagged structural paths from Time 1 learning-related behavior to the Time 2 and Time 3 DCS dimensions.
- (M3) Reciprocal causation model (M_3): M_0 extended with reciprocal cross-lagged structural paths (i.e., the regular paths included in model M_1 as well as the reversed paths included in model M_2).
- (M4) Reciprocal causation model with equal cross-lagged normal and reversed effects of the DCS dimensions and learning-related behavior: To determine the causal predominance of the normal and reversed cross-lagged effects, the normal and reversed effects between the DCS dimensions and learning-related behavior are constrained to be equal.

Age effects

Analysis of variance (ANOVA) was used to test Hypotheses 3 and 4 regarding mean differences among the age groups. To test whether the postulated reciprocal causal model differed as a function of age, we applied multiple-group analysis using SEM (Jöreskog & Sörbom, 1993). The advantage of this method is that all cross-lagged effects in Figure 1 could be tested simultaneously for all three age groups. In line with Byrne's (1998) suggestions, we first tested the proposed standardized cross-lagged effects for each subgroup separately (forming a baseline model). Then we tested for invariance across the age groups. All model tests were based on the covariance matrix and using maximum likelihood estimation. In judging the fit of models we considered both the χ^2 -value and other fit indexes, including the goodness-of-fit index (GFI), the non-normed fit index (NNFI), and the root-mean square error of approximation (RMSEA). Levels of .90 or better for GFI and NNFI and levels of .05 or lower for RMSEA signify acceptable fit (Byrne, 1998).

Results

Prior to the multi-group SEM analyses, preliminary analyses were carried out to gain insight into the data, and to examine meaningful differences among the age groups (cf. Kooij, De Lange, Jansen, & Dijkers, 2008). Table 1 shows that the age groups differed significantly regarding job tenure, gender, leadership position, family situation, and number of care-needing persons at home. Not surprisingly, older workers had significantly higher job tenure, occupied more often a supervisory position than younger workers, whereas the middle-aged workers experienced significantly more care-giving tasks than other workers. No significant differences emerged for educational level, socio-economic status, career possibilities, experienced recognition, rewards and job security among the age groups.

Tables 2a and 2b present the correlations among the variables under study for the total group of respondents and the three age groups separately. As regards the across-time stability of the variables, the Time 1–Time 2 test–retest correlations ranged from .47 (for Supervisor support), and .50 (for Demands) to .67 (for Control, all p 's < .001); the Time 2–Time 3 test–retest correlations ranged from .56 (for Supervisor support), and .52 (for Demands) to .68 (for Control; all p 's < .001), and the Time 1–Time 3 test–retest correlations ranged from .43 (for Demands), .49 (Supervisor support), .55 (active problem solving) to .71 (Control; all p 's < .001). Thus, the stability and reliability of the measures was satisfactory.

Hypotheses 1 and 2: Are there reciprocal cross-lagged relationships between job demands, control, supervisor support, and indicators of learning-related behavior?

In order to examine Hypotheses 1 and 2, the fit of the four competing structural models M_0 – M_3 (see Method) was compared (Table 3). The fit of all models was satisfactory (NNFI, GFI \geq .90 and RMSEA \leq .05).

Table 1. Demographic characteristics and information on type of work and home situation across age groups (means and standard deviation scores are presented between brackets)

Variables	≤30 (<i>N</i> = 407)	31–44 (<i>N</i> = 601)	≥45 (<i>N</i> = 229)	Univariate <i>F</i>
Age*	26.2 (2.50)	37.2 (3.97)	48.5 (2.79)	<i>F</i> (2, 642) = 1733.89
Job tenure*	4.52 (2.48)	10.86 (7.06)	17.86 (9.73)	<i>F</i> (2, 642) = 161.69
% Men*	57%	78.7%	72.8%	<i>F</i> (2, 642) = 24.86
% Level of education				
1: Primary or lower	5.0%	10.6%	23.2%	<i>F</i> (2, 642) = 1.85
2: Lower vocational	44.7%	39.8%	37.0%	
3: Secondary or middle vocational	33.7%	26.6%	21.4%	
4: Higher vocational	7.8%	10.3%	9.5%	
5: College/University	7.7%	11.7%	7.3%	
% Socio-economic status				
1: Blue collar jobs	74.2%	69%	71.6%	<i>F</i> (2, 642) = 2.59
2: White collar job	25.7%	31%	28.4%	
% Sufficient career possibilities (yes)	54.7%	53.0%	46.5%	<i>F</i> (2, 642) = .30
% Sufficient recognition (yes)	67.7%	68.7%	69.1%	<i>F</i> (2, 642) = .91
% Sufficient rewards (yes)	60.2%	59.3%	63.0%	<i>F</i> (2, 642) = .57
% Leadership position*	7.5%	15.2%	20.2%	<i>F</i> (2, 642) = 11.50
% Job change in past 12 months (no)	84.7%	84.4%	84.4%	<i>F</i> (2, 642) = .80
% Job security (agree)	89.2%	88.1%	87.5%	<i>F</i> (2, 642) = .00
% Family situation*				
1: Unmarried, not living together,	17.2%	11.2%	7.0%	<i>F</i> (2, 642) = 9.74
2: Married or living together,	63.0%	80.1%	81.0%	
3: Divorced, not living together,	1.3%	2.8%	4.0%	
4: Widowed, not living together	0.0%	0.0%	.9%	
5: Living with parents	14.0%	1.2%	2.4%	
% Children or other care-needing persons at home (yes)?*	10%	30.3%	20.5%	<i>F</i> (2, 642) = 59.44

Note: All variables are measured on Time 1, Multivariate $F(112, 4375) = 8.93$.

*Significant differences between groups ($p < .001$).

Further, we compared the nested structural models M_1 – M_3 to the baseline model M_0 using the χ^2 -difference test, in order to see whether the nested models show a better fit than the baseline model without these relationships. Table 3 shows that models M_1 – M_3 fitted the data significantly better than the baseline model M_0 . Thus, the DCS dimensions and learning-related behavior were indeed related. The results also show that the reciprocal model (M_3) accounted better for the data than the normal causation model (M_1 versus M_3 : $\Delta\chi^2(12, N = 1237) = 43.76$, $p < .05$), and the reversed causation model (M_2 versus M_3 : $\Delta\chi^2(6, N = 1237) = 45.21$, $p < .05$). Figure 2 presents the significant cross-lagged effects of the best fitting reciprocal causal model (M_3). Specifically, for Time 3 motivation to learn significant positive cross-lagged effects were found of Time 1 job control ($\beta = .12$), Time 2 job demands ($\beta = .07$), and positive cross-sectional effects of Time 3 job demands ($\beta = .07$) and job control ($\beta = .39$). For Time 3 active problem solving significant cross-lagged effects were found of Time 1 job control ($\beta = .07$), and significant cross-sectional effects of Time 3 job demands ($\beta = .06$), and job control ($\beta = .12$). These results provide evidence for positive effects of job demands as well as job control in predicting learning-related behavior across time. No significant effects were found for supervisor support (Hypotheses 1a and 1b supported; 1c not supported).

Table 2a. Correlations among the research variables for all workers in the upper diagonal ($N = 1237$), and for the young workers (≤ 30 years, $N = 407$) in the lower diagonal; listwise deletion of missing values

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1 Age	—	-.17	-.08	.59	.03	.11	.04	.07	.03	.11	.00	.04	.04	-.03	.01	.03
2 Gender ^a	-.23	—	.16	-.22	.03	-.17	.03	-.13	.01	-.14	.04	-.01	-.17	.05	-.11	-.13
3 Education ^b	.11	.25	—	-.19	-.02	.22	-.01	.28	-.02	.21	.01	.04	.23	.05	.31	.34
4 Job tenure	.42	-.06	-.19	—	.03	.09	-.02	.00	-.01	.07	-.04	.01	.04	-.03	-.03	.06
Time 1																
5 Demands	.10	.04	.02	.10	—	-.02	-.17	.04	.55	-.01	-.11	.47	-.03	-.11	.04	.02
6 Control	.17	-.05	.21	-.02	-.03	—	.26	.31	-.02	.64	.14	.03	.59	.18	.31	.47
7 Supervisor support	-.01	.04	.09	-.10	-.21	.27	—	.00	-.10	.15	.47	-.12	.18	.37	.00	.05
8 Active problem solving	.21	-.11	.22	.02	.07	.30	.04	—	-.02	.27	-.01	.09	.31	.06	.59	.45
Time 2																
9 Demands	.06	-.01	.04	.04	.56	-.03	-.07	-.02	—	-.06	-.21	.54	-.07	-.18	.01	.05
10 Control	.13	-.06	.17	-.05	.00	.61	.14	.24	-.07	—	.33	.02	.62	.20	.27	.45
11 Supervisor support	.05	.05	.05	-.12	-.12	.18	.40	.06	-.21	.33	—	-.15	.22	.47	.04	.07
Time 3																
12 Demands	.08	-.01	.05	.05	.43	.06	-.11	.10	.55	.08	-.14	—	.00	-.23	.11	.14
13 Control	.12	-.11	.20	-.02	-.07	.53	.22	.25	-.04	.57	.26	.04	—	.36	.34	.57
14 Supervisor support	.07	.03	.06	-.04	-.15	.22	.40	.11	-.15	.20	.47	-.15	.41	—	.08	.11
15 Active problem solving	.16	-.05	.23	-.02	-.01	.27	.04	.55	-.02	.24	.08	.09	.28	.11	—	.48
16 Motivation to learn	.11	-.05	.27	.00	.04	.43	.09	.44	.13	.36	.09	.18	.55	.15	.49	—

Note: Overall sample, $N = 1237$; correlations of .06 and higher significant at $p < .05$. Sample of young workers, $N = 407$; correlations of .10 and higher significant at $p < .05$.

^aGender: 1 = male and 2 = female.

^bEducation: 1 = primary or lower, 2 = lower vocational, 3 = secondary or middle vocational, 4 = higher vocational, 5 = College/University degree.

Figure 2 also shows significant reversed effects of Time 1 active problem solving on reported DCS dimensions across time. Specifically, Time 1 active problem solving was significantly related to Time 2 job demands ($\beta = -.05$; this is presumably a suppressor effect, as the underlying correlation was positive), Job control ($\beta = .06$), Time 3 job demands ($\beta = .08$), job control ($\beta = .10$), and supervisor support ($\beta = .06$). Overall, the results show that Time 1 active problem solving was related to more job demands, job control as well as supervisor support across time.

The question remains whether the normal versus reversed pattern is causally predominant. We therefore tested the equality of the normal and reversed β coefficients (model M_4 ; see Method). Table 3 shows that the χ^2 -difference between the models with and without equality constraints was not significant (M_3 versus M_4 : $\Delta\chi^2(3, N = 1237) = 6.86, p > .05$). Consequently, the normal and the reversed cross-lagged effects between the DCS dimensions and learning-related are comparable (supporting Hypotheses 1a, b, c and 2).

Hypotheses 3 and 4: Do older workers report significantly lower levels of motivation to learn, active problem solving, supervisor support, and more job control than their younger colleagues?

To examine Hypotheses 3 and 4, a 3 (Age; young workers versus middle-aged workers versus older workers) \times 2 or 3 (Time: Time 1, Time 2, and Time 3) ANOVA with Time as a within-participants factor and Group as a between-participants factor was carried out. Main effects of Age were found for Time 1 job control, $F(2, 1225) = 11.24$; Time 2 job control, $F(2, 1225) = 5.80$; Time 3 job control, $F(2, 1225) = 8.90$; Time 1 active problem solving, $F(2, 1225) = 5.64$; Time 3 active problem solving, $F(2, 1225) = 7.67$; and for Time 3 motivation to learn, $F(2, 1225) = 3.79$ (all p 's $< .05$). Table 4 also shows

Table 2b. Correlations between research variables for middle aged workers in upper diagonal (31–44 years; $N=601$), and for old workers in lower diagonal (≥ 45 years; $N=229$); listwise deletion of missing values

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1 Age	—	-.02	-.05	.34	-.01	.08	.06	.02	.00	.10	.06	.00	.03	.05	.00	.02
2 Gender ^a	-.01	—	.09	-.09	.02	-.17	.03	-.13	.01	-.13	.02	-.01	-.17	.04	-.14	-.15
3 Education ^b	-.08	.18	—	-.15	-.07	.24	-.03	.28	-.05	.26	-.02	.05	.27	.00	.31	.39
4 Job tenure	.16	-.41	-.26	—	.02	.02	-.03	-.06	-.08	.02	.02	-.04	.01	.02	-.07	.06
Time 1																
5 Demands	-.01	.02	.04	.02	—	-.04	-.17	-.01	.55	-.02	-.13	.48	-.02	-.10	.02	.03
6 Control	-.00	-.30	.20	.19	.02	—	.29	.33	-.05	.64	.12	.03	.60	.17	.33	.45
7 Supervisor support	.04	.01	-.09	-.04	-.10	.15	—	.04	-.09	.18	.49	-.12	.19	.41	.00	.05
8 Active problem solving	-.06	-.08	.37	-.01	.13	.23	-.13	—	-.06	.30	-.04	.03	.35	.03	.57	.39
Time 2																
9 Demands	.01	.01	-.04	.01	.50	.04	-.18	.08	—	-.09	-.22	.52	-.10	-.17	-.04	.01
10 Control	.00	-.20	.18	.10	-.01	.64	.13	.23	-.01	—	.32	.00	.63	.19	.29	.45
11 Supervisor support	-.01	.08	-.02	-.09	-.05	.11	.55	-.05	-.17	.32	—	-.18	.19	.50	.03	.06
Time 3																
12 Demands	.01	.01	.02	.03	.50	-.03	-.16	.19	.56	-.03	-.08	—	-.02	-.27	.06	.12
13 Control	.01	-.22	.15	.11	.02	.65	.12	.25	-.04	.65	.17	-.04	—	.32	.36	.54
14 Supervisor support	.00	.11	.12	-.02	-.05	.14	.24	.08	-.22	.23	.36	-.25	.35	—	.05	.08
15 Active problem solving	-.01	-.09	.38	.04	.16	.29	-.04	.68	.15	.29	.00	.22	.37	.10	—	.45
16 Motivation to learn	-.00	-.20	.31	.13	-.05	.56	.04	.52	.07	.48	.05	.15	.59	.09	.57	—

Note: Middle-aged sample, $N=601$; correlations of .08 and higher significant at $p < .05$. Sample of older workers, $N=229$; correlations of .13 and higher significant at $p < .05$.

^aGender: 1 = male and 2 = female.

^bEducation: 1 = primary or lower, 2 = lower vocational, 3 = secondary or middle vocational, 4 = higher vocational, 5 = College/University degree.

significant Time effects for Time 1–3 Job control, Time 1–3 active problem solving, and Time 3 motivation to learn. *Post hoc* Least square difference tests and regression analyses revealed significant inverted u-curve relationships between age, job control, motivation to learn, and active problem solving. Most significant effects were found when comparing the middle-aged workers compared to young as well as older workers. The middle-aged group of workers reported significantly higher levels of job control, active problem solving, and motivation to learn compared to the younger and older groups of workers. Moreover, the significant Time \times Age group effect for active problem solving revealed that all workers showed a significant decrease in active problem solving across time, of which the older workers showed the greatest decline in active problem solving. All in all, the older workers

Table 3. Fit indices for different nested models ($N=1237$)

Model	χ^2 ^a	df	NNFI	GFI	RMSEA
M ₀ : Baseline model (stability effects only)	129.59	36	.95	.99	.046
M ₁ : Normal causality ^b	84.38	24	.95	.99	.045
M ₂ : Reversed causality ^b	85.83	30	.96	.99	.039
M ₃ : Reciprocal causality ^{b,c}	40.62	18	.98	1.00	.032
M ₄ : Reciprocal causality ^b (equal normal and reversed effects DCS-learning-related behavior)	47.48	21	.98	1.00	.032

^aAll χ^2 -values are significant at $p < .001$.

^bThis χ^2 -value is significantly lower ($p < .001$) than that of Model M₀.

^cThis χ^2 -value is significantly lower ($p < .001$) than that of Models M₁ and M₂.

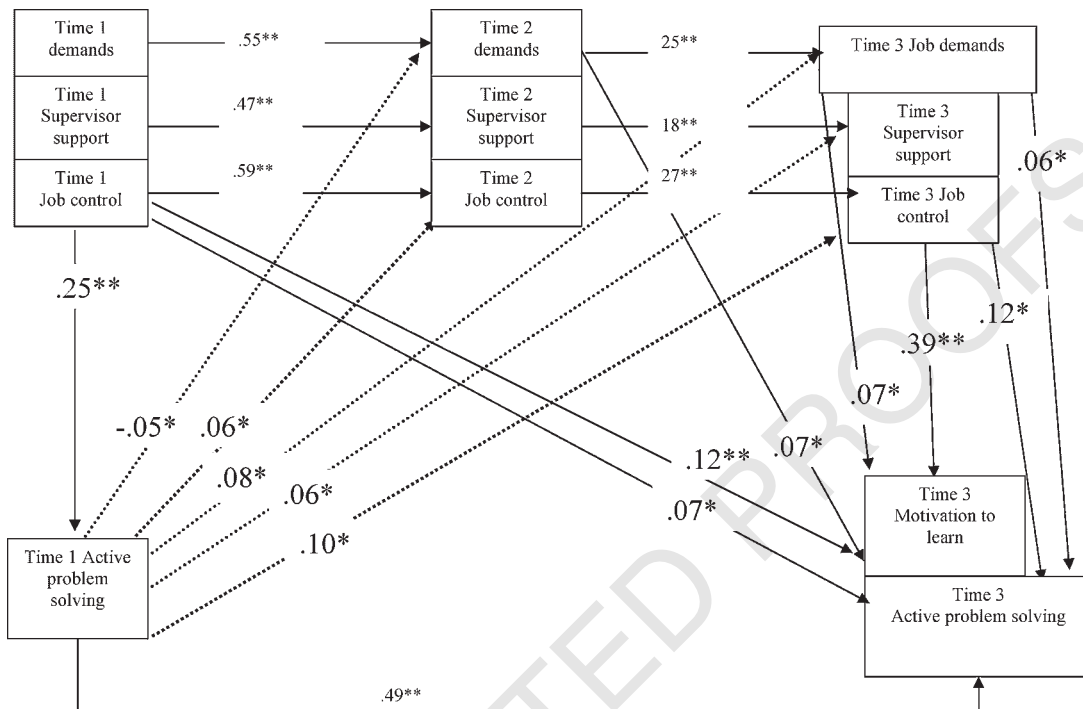


Figure 2. Standardized results for all workers (N = 1237)

Note: * $p < .05$; ** $p < .01$.

indeed reported lower motivation to learn and active problem solving than middle-aged workers, but not compared to the youngest group of workers (Hypothesis 3 partially supported). Furthermore, the results do not confirm Hypothesis 4, as we found no consistent evidence that the older workers reported significantly higher levels of job control or lower levels of supervisor support than the other age groups.

Age differences in cross-lagged effects of DCS dimensions and active problem solving behavior?

In the aforementioned structural equation analyses for the whole sample, M_4 (with the normal and reversed cross-lagged effects constrained as equal) fitted the data significantly better than M_3 (reciprocal causal model). However, the χ^2 -difference test comparing M_3 – M_4 among the middle-aged workers revealed that the normal and the reversed cross-lagged effects between the DCS dimensions and learning-related behavior were not comparable (M_3 versus M_4 : $\Delta\chi^2(3, N = 601) = 9.43, p < .05$; cf. the footnote to Table 5). Consequently, to examine potential age differences in the cross-lagged relationships between the DCS dimensions and active problem solving behavior, we conducted several multiple-group analyses using the fit indices of the reciprocal causal model (M_3 ; revealing a satisfactory fit for all age groups), and compared five nested models by means of the χ^2 -difference test. These nested models were: M_5 (variant reciprocal model): The hypothesized cross-lagged relationships in Figure 1 are allowed to vary across the age groups; M_6 (Beta invariant reciprocal

Table 4. Comparison of mean scores across the age groups (standard deviations in brackets)

Variables	Age groups				MANOVA <i>F</i> -values		
	≤30 (<i>N</i> = 407)	31–44 (<i>N</i> = 601)	≥45 (<i>N</i> = 229)	Total (<i>N</i> = 1237)	<i>F</i> (Age) ^a	<i>F</i> (Time) ^b	<i>F</i> (Age × Time) ^b
T1 Demands	2.60 (.45)	2.58 (.47)	2.63 (.46)	2.59 (.45)	.51		
T2 Demands	2.53 (.49)	2.52 (.47)	2.58 (.52)	2.65 (.47)	.90		
T3 Demands	2.57 (.46)	2.60 (.46)	2.63 (.48)	2.59 (.47)	1.18	9.44**	.82
T1 Job control	2.78 (.47)	2.92 (.46)	2.85 (.51)	2.86 (.48)	11.24*** ^c		
T2 Job control	2.81 (.46)	2.94 (.46)	2.88 (.54)	2.88 (.47)	5.80*** ^c		
T3 Job control	2.82 (.48)	2.92 (.46)	2.81 (.53)	2.87 (.48)	8.90*** ^c	2.48	.28
T1 Supervisors support	2.74 (.53)	2.73 (.53)	2.72 (.57)	2.74 (.54)	.76		
T2 Supervisors support	2.67 (.59)	2.70 (.54)	2.63 (.69)	2.65 (.57)	2.00		
T3 Supervisors support	2.66 (.59)	2.65 (.58)	2.56 (.62)	2.64 (.59)	3.73	23.74*	2.25
T1 Active problem solving	2.52 (.52)	2.63 (.55)	2.59 (.60)	2.58 (.56)	5.64*** ^c		
T3 Active problem solving	2.41 (.50)	2.49 (.53)	2.42 (.57)	2.44 (.53)	7.67*** ^c	88.33**	3.2*
T3 Motivation to learn	2.06 (.50)	2.18 (.52)	2.07 (.54)	2.11 (.52)	3.79*** ^c		
Covariates							
T1 Age	26.2 (2.50)	37.2 (3.97)	48.5 (2.79)	35.76 (8.5)			
T1 Gender	1.43 (.50)	1.22 (.41)	1.25 (.44)	1.29 (.46)			
T1 Education	2.71 (.98)	2.82 (1.17)	2.45 (1.20)	2.71 (1.12)			
T1 Job tenure	4.52 (2.48)	10.86 (7.06)	17.86 (9.73)	9.62 (7.58)			

Note: Age groups are based on Time 1 Calendar age. Multivariate $F(24, 2430) = 2.27^{**}$; the results remained significant after controlling for level of education, gender and job tenure.

^aAll *F*-values have (2,1225) degrees of freedom.

^bAll *F*-values have (2,2536) degrees of freedom, except T3 Active problem solving, where *df* = (1,1360).

^cRegression analyses revealed significant inverted u-shaped relationships ($p < .01$) between age and T1 job control: $F(2, 1268) = 20.04$, T2 job control: $F(2, 1268) = 18.76$, T3 job control: $F(2, 1268) = 11.10$, T3 Motivation to learn: $F(2, 1268) = 10.73$, T1 active problem solving: $F(2, 1268) = 15.05$, T3 active problem solving: $F(2, 1268) = 6.33$.

* $p < .05$; ** $p < .01$.

model): In which the cross-lagged effects are presumed to be invariant across the three age groups; and M_7 – M_9 , in which the β 's of certain age groups are presumed to be equal (for example, in M_7 the β 's of young and older workers are constrained to be equal).

Table 5 presents the fit indices and χ^2 -difference tests of these models, revealing that the variant model fits the data better than the invariant model (M_5 versus M_6 : $\Delta\chi^2(40) = 63.48$, $p < .05$). When comparing the variant model M_5 with Models M_7 – M_9 (see Appendix 1 with syntax of M_9), M_9 did not account better for the data than M_5 . Further, Figure 3 shows that most significant differences were found between the middle-aged and older workers.

To further examine the effects of the covariates (Cohen, Cohen, West, & Aiken, 2003), we performed a *Post hoc* χ^2 -difference test of the variant model 5 with a new invariant model 10 (with the covariate effects constrained invariant across the age groups). The results revealed a non-significant χ^2 -difference test (M_5 versus M_{10} : $\Delta\chi^2(136, N = 1237) = 151.82$, $p > .05$). Considering that parsimonious models (i.e., models with relatively few parameters) should be preferred to more complex models with the same fit (Kelloway, 1998), the results show that the covariate effects can be constrained equal across

Table 5. Fit indices and χ^2 -difference tests of different nested models using multi-group analyses ($N = 1237$)

Model	χ^2	df	NNFI	GFI	RMSEA	Comparison	$\Delta\chi^2$	Δdf
M ₅ M ₃ ^a , Variant reciprocal model	78.41*	54	.97	.99	.032			
M ₆ M ₃ , Be invariant across age groups	141.89*	94	.97	.97	.034	M ₅ vs. M ₆	63.48*	40
M ₇ M ₃ , Be invariant for group 1 and 3	106.39	74	.98	.97	.031	M ₅ vs. M ₇	27.98	20
M ₈ M ₃ , Be invariant for group 1 and 2	103.74	74	.99	.97	.030	M ₅ vs. M ₈	24.59	20
M ₉ M ₃ , Be invariant for group 2 and 3	121.21	74	.96	.97	.038	M ₅ vs. M ₉	42.80**	20

* $p < .05$; ** $p < .01$.^aFit indices reciprocal causation model (M₃ and M₄) for each age group:

Age groups	χ^2	df	NNFI	GFI	RMSEA	$\Delta\chi^2$	Δdf
M ₃ Young workers (≤ 30 years, $N=407$)	31.31*	18	.95	.99	.043	2.45	3
M ₄ Young workers (≤ 30 years, $N=407$)	33.76*	21	.96	.99	.039		
M ₃ Middle-aged workers (31–44 years, $N=601$)	21.28	18	.99	1.00	.017	9.43*	3
M ₄ Middle-aged workers (31–44 years, $N=601$)	30.71	21	.99	.99	.028		
M ₃ Older workers (≥ 45 years, $N=229$)	25.83	18	.95	.99	.040	1.57	3
M ₄ Older workers (≥ 45 years, $N=229$)	27.40	21	.97	.99	.033		

* $p < .05$; ** $-p < .01$.

the age groups. The results showed significant effects of all covariates in predicting Time 1 job control (β 's ranging from .05 for age ($p < .05$) to .28 for education ($p < .01$)), but no significant effects were found for Time 2 job control, and small effects were found for Time 3 job control (β 's ranging from .06 for education ($p < .05$) to $-.07$ for gender, $p < .05$). For Time 1 problem solving significant effects were found of gender ($\beta = -.14$, $p < .01$) and level of education ($\beta = .22$, $p < .01$), whereas for Time 3 problem solving only significant effects of level of education were found ($\beta = .12$, $p < .01$). Finally, a significant effect of education was also found for Time 3 Motivation to learn ($\beta = .16$, $p < .01$).

Considering the across-time effects between the DCS dimensions and learning-related behavior, Figure 3 shows that positive effects were found of job demands and control in relation to active problem solving behavior, and positive reversed effects were found of active problem solving on reported job demands or job control. The middle-aged workers reported negative effects of Time 1 supervisor support ($\beta = -.09$) and positive effects of Time 1 job control ($\beta = .11$) on Time 3 active problem solving. The middle-aged workers also reported significant reversed effects of active problem solving on Time 2 and 3 job control (β 's were .07/.12; $p < .05$), whereas the young and older workers reported only positive effects of active problem solving on Time 3 job demands (β 's were .09/.14; $p < .05$). In sum, we found significant age group differences in the effects of the DCS dimensions and active problem solving behavior, with the effects for the middle-aged workers being the strongest.

Discussion

The aims of this 3-wave study were to test whether: (a) Exposure to job demands and job control as well as social support predict later reported learning-related behavior, (b) whether there is evidence

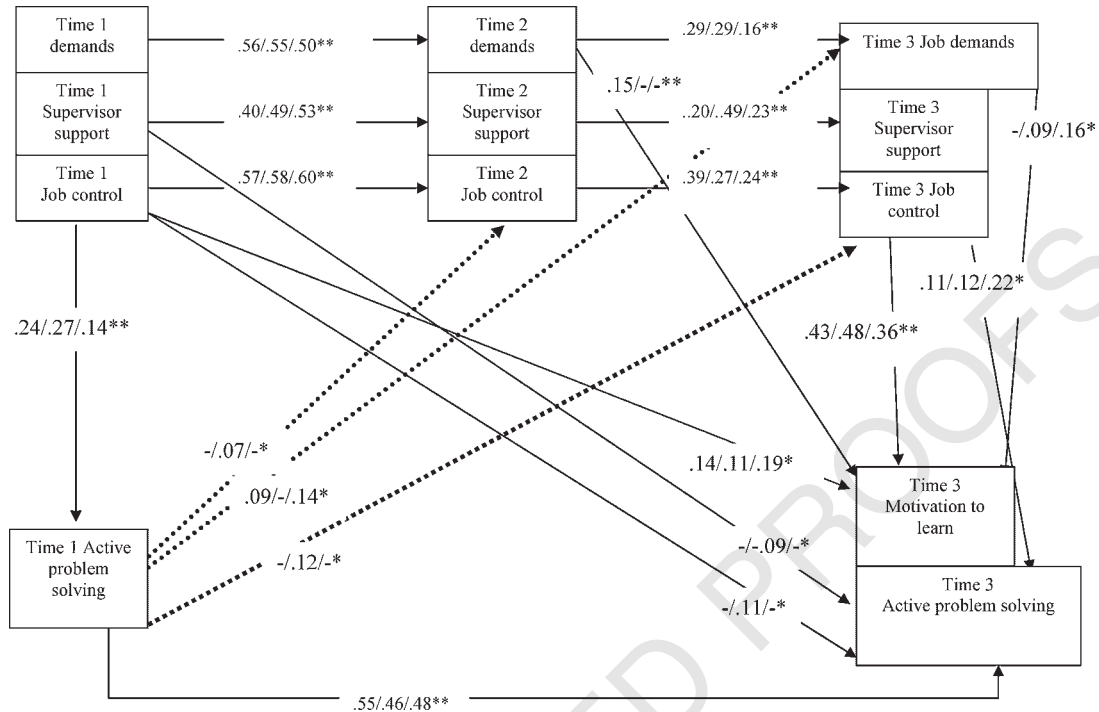


Figure 3. Standardized results for age groups.

Note: .55/.46/.48** refer to significant autocorrelations for respectively young/middle-aged/older; -: Refers to not significant effect; * $p < .05$; ** $p < .01$.

for reversed effects of learning-related behavior on job demands, job control or social support, and (c) whether there are meaningful age differences in the aforementioned relations. The results of the “causal direction” analyses confirmed the hypothesized bidirectional or reciprocal nature of the relationships under study. Besides the positive cross-lagged effects of job demands and job control on learning-related behavior across time (supporting Hypotheses 1a and b), this study was the first to find reversed effects of active problem solving behavior on reported job demands, control as well as supervisor support across time (supporting Hypothesis 2).

These results are not only in line with the activation hypothesis of the Demand–Control–Support model (Karasek & Theorell, 1990) but also provide evidence for the “active shaper” reversed causation hypothesis. Specifically, the results suggest that the one-directional view on the relationship between work and learning-related behavior postulated in the DCS model does not capture the full picture. In line with earlier life-span developmental theory, the notion of reciprocal determinism (Bandura, 1997; Taris et al., 1998) and Hobfoll’s (2001) conservation of resources theory, our results show that workers are active shapers who try to increase their job resources, rather than just being passive receivers of environmental influences.

Furthermore, the results show that age effects matter in the relationships between work and learning-related behavior. Our multigroup analyses revealed significant inverted u-curve relationships between age, job control, and learning-related behavior, such that the middle-aged workers reported significantly more job control and learning-related behavior than the young and older workers (partially supporting Hypothesis 3, and rejecting Hypothesis 4). Further, age differences were found in the cross-lagged relationships between job demands, control, and learning-related behavior. Especially the older and middle-aged workers differed significantly in terms of the cross-lagged effect sizes obtained for

these groups. The middle-aged workers reported more significant effects of the DCS dimensions in predicting learning-related behavior, and different reversed effects of active problem solving (on job control) than the other workers (who reported only reversed effects on job demands). Thus, middle-aged workers stand out regarding their high levels of job control and learning-related behavior.

Possible explanations for these effects may be that middle-aged workers have transferred to the jobs with higher levels of job control that fit their self-concept (job change hypothesis of Wright & Hamilton, 1978), but still see changes for job transfer to other interesting positions, whereas older workers have reached the highest position possible in the company, and do not have options for further (internal or external) job transfer (Hedge, Borman, & Lammlein, 2006). Another explanation is that job control has a time-limited effect, showing stronger effects among younger workers (Bradley, 2007). Furthermore, older workers (who see retirement approaching quicker than middle-aged workers) may take a reduced time perspective, resulting in motivational consequences like a lower motivation to learn (Carstensen & Charles, 1998). Similarly, Hansson, DeKoekkoek, Neece, and Patterson (1997) showed that the accomplishment of one's late career goals can result in detachment from the career and in pursuing new learning activities that are less career-related. A final explanation is the differential treatment in the work environment of middle-aged versus younger and older workers. Earlier research has revealed that supervisors hold negative stereotypes, provide less organizational developmental or training activities to and treat older workers less fairly than middle-aged or younger workers (Simpson, Greller, & Stroh, 2002; Van der Heijden et al., 2009). This suggests that the position of the middle-aged workers in the organization is much more favorable than that of both younger and older workers.

Study limitations

The most important limitations of our study are the following. First, the findings reported in this study were based on self-reports and may therefore be subject to bias, e.g., due to personality traits such as negative affectivity (Frese & Zapf, 1988). However, Spector (2006) argued that the problem of common method variance is overstated and may even be outdated, as it is more a question of measurement bias than bias of the method itself. Our scales showed good reliability scores as well as a good fit of the measurement models across time, and we therefore expect that the measurement bias in this study is relatively small. Furthermore, the 3-wave longitudinal design allowed us to control for earlier levels of most of the variables, and as a result potential common method variance (Zapf, Dormann, & Frese, 1996), but there may always be unknown third variables that could not be controlled for.

A second limitation follows from the longitudinal design of this study. Although longitudinal data are potentially much better suited for studying causal direction of relationships than cross-sectional data (Taris, 2000), whether this benefit is fully realized depends on the degree to which the time lag between waves suits the process and etiology of the relationship between the research variables under study (De Lange et al., 2004). We have employed a time lag of 1 and 2 (and a total of 3) years, and found relatively the strongest normal causal effects across 3 years, and reversed effects across 1 year. Nonetheless, the chosen time lags may be too long or too short in revealing the true dynamics between work and learning-related behavior, and age. For example, smaller time lags (such as 3 months) may reveal larger effects of the psychosocial work characteristics in predicting learning-related behavior, whereas longer lags may be needed to fully examine effects of intra-individual age effects across time (De Lange et al., 2004). Furthermore, we were unable to examine a complete longitudinal design as the learning-related behavior variables were not measured on all occasions; we were therefore unable to control for all synchronous effects and auto-correlations (Zapf et al., 1996).

We found relatively small effect sizes for the relationships between the DCS dimensions and learning-related behavior. According to Semmer, Zapf, and Greif (1996), small standardized effects are

to be expected as they argue that there is an upper limit of 15–20 per cent variance in strain that can be explained by job stressors. Moreover, it is important to note that the cross-lagged effects of, for instance, job demands on active problem solving refer to predicting *changes* in active problem solving from Time 1 to Time 3 (i.e., after controlling for Time 1–Time3 stability effects). By definition these effects will be small, as many phenomena will be relatively stable across time. Thus, the small effects found in this study may also be regarded as common in longitudinal research (and not a major limitation).

Furthermore, it is difficult to disentangle the age differences found in this study from so-called ‘cohort’ effects; the result of common experiences peculiar to a particular historical period in which workers were born (Kanfer & Ackerman, 2004). We cannot exclude that historical differences in the experiences of the different cohorts account for the differences among age groups (Folkman et al., 1987). For example, the positive results obtained for the middle-aged workers may also be explained by the fact that they have found themselves in a work context optimized with the (then) current and accepted methods, practices and technologies so that a cohort explanation might be equally valid as an aging explanation. Moreover, we must also point to the particular context of this study. As the Dutch funded pension programs (in the late 1990s), and protected retirement programs may have contributed to lower levels of motivation to learn in the older workers of this study, we cannot directly generalize the findings to other national contexts and current situations with less favorable pension programs. For example, in countries like the United State, retirement-aged workers face increasing uncertainty about the future of their social security benefits and the age requirement to receive a full social security pension continues to increase. Thus, in such countries the incentives for keeping one’s skills and knowledge up-to-date may be much stronger than in countries having liberal pension programs.

Study implications

In spite of these limitations, we feel that our findings have implications for both practice and future research. From a practical point of view, the normal causal effects found in this study indicate that interventions directed at increasing job control may be useful in improving the motivation to learn of all age groups (even after 3 years), but that increasing job demands or supervisor support may have different effects across the age groups. Further, an implication of the evidence found for reciprocal relationships is that workplace interventions should also address the long-term effects in employees. Middle-aged workers may benefit from learning new skills in crafting their jobs with more job control across time, whereas younger and older workers report more reversed effects on their job demands. Our subgroup analyses also revealed that younger and older workers may need more positive attention to increase their learning-related behavior.

Research agenda

This longitudinal study is the first to investigate the causal direction as well as effects of aging in relationships between psychosocial work characteristics and learning-related behavior across time. Further research should investigate why and how these effects develop across time, and can specify more dynamic theories and hypotheses regarding these effects. We feel the results found call for:

- (1) *Meta-analyses*: As it is too early to draw strong conclusions regarding the relationships between work, learning-related behavior, and aging based on one study, we call for meta-analyses

examining results of earlier longitudinal studies. Meta-analyses on the longitudinal dynamics between job demands, job control, and supervisor support versus learning-related behavior, and on the effects of aging are needed to determine actual effect sizes.

- (2) *Direct measures of underlying concepts:* Reviews of the relationships between age and organizationally relevant outcomes (e.g., Kooij et al., 2008; Sterns & Miklos, 1995; Warr, 2001) have suggested that chronological or calendar age serves as a proxy measure for many age-related processes (Kanfer & Ackerman, 2004). In line with Sterns and Doverspike (1989) and De Lange et al. (2006), it is important to examine other operationalisations of the factor age like: (a) Performance-based or functional (e.g., work ability or health measures); (b) psychosocial or subjective (e.g., how old the person desires to be or age norms applied to an individual with respect to an occupation, company, or society; cf. Kaliterna, Larsen, and Brkljacic (2002)); (c) organizational (e.g., job tenure, career stage); and (d) life-span approaches (e.g., family status or life stage measures). In our analyses, controlling for the organizational age measure job tenure, and the life span age measures family status and care-needing people (cf. Table 1) did not alter our results found. However, future studies could include more age measures like age norms or health. By measuring and examining these underlying age-related processes, we may better explain the effects of age. For example, Hwalek et al. (1982) have argued that the social pressure resulting from age norms is the strongest factor in the aging process and the decision to retire (see also McCann & Giles, 2002), and therefore these psychosocial variables should be included in future studies on the relationships between work and learning-related behavior.
- (3) *Theory-based longitudinal and experimental studies:* We hope that our results will inspire researchers to develop innovative, theory-based, longitudinal, or experimental (as opposed to cross-sectional and correlational) studies on the causal relations between work and learning-related behavior. These studies should further examine the explanatory mechanisms for the reversed effects of learning-related behavior on work. In line with De Lange et al. (2005), one should distinguish between *environmental* change and *perceptual* change mechanisms for such reversed effects. Environmental change mechanisms for possible reversed effects of learning-related behavior include: (a) Internal job changes: The worker's newly-learned skills could result in self-determined or supervisor-directed changes in the current job (a worker may seek new challenges, or the worker's supervisor could provide new tasks), or (b) external job changes: Newly learned skills could make a worker more attractive to other companies (De Lange et al., 2008). In these reversed environmental effects, the learning process and newly learned skills facilitate promotion to new and more challenging work environments (Frese et al., 2007; Wrzesniewski & Dutton, 2001). On the other hand, perceptual reversed mechanisms reflect within-person perceptual (and not actual) changes in the work environment. For example, due to higher feelings of mastery due to learning, the same job demands could be perceived as being less demanding (cf. Taris et al., in press). We need more controlled experimental designs to further disentangle environmental from perceptual change mechanisms for reversed effects.

For the effects of aging at work, it is important to include insights of life span theories into occupational health models like the DCS model. For example, insights of Selection, Optimization, and Compensation (SOC) theory (Baltes et al., 1999), Socio-emotional selectivity theory (Carstensen, 1998), and Regulatory focus theory (Higgins, 1997) can be integrated into job design models. These life span theories highlight important regulatory processes and underlying variables such as time perspective that may explain the motives of older workers to continue learning at work (Carstensen, 1998; Higgins, 1997).

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Appendix 1:

Model 9 reciprocal causation multigroup analysis (with beta's of groups 2 and 3 invariant)

Group 1=young workers
da NG=3 ni=16 no=407 ma=cm
km sy
See Table 2a
sd
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Group 2= Middle-aged workers

Da NO=601

km sy

See Table 2a

sd

4.08 .41 1.15 6.92 .46 .49 .53 .57 .46 .47 .55 .46 .46 .58 .54 .51

Group 3=Older workers

Da NO=229

km sy

See Table 2b

sd

3.33 .45 1.16 9.70 .46 .52 .58 .62 .52 .54 .69 .47 .51 .61 .59 .54

la

age gend educ jobtenu dem1 con1 ssup1 t1prob t2dem t2contr t2ssup t3dem t3cont t3ssup t3prob t3mol/

mo ny=16 ne=16 ly=id te=ze be=fu,fi ps=sy,fi

le

age gend educ jobtenu dem1 con1 ssup1 t1prob t2dem t2contr t2ssup t3dem t3cont t3ssup t3prob t3mol/

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eq be (2 16 6) be (3 16 6)

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